

Article

Effects of Three Selected Pollinator-Friendly Practices on Garden Eggplants (*Solanum aethiopicum*) at Mankessim in the Central Region of Ghana

Millicent Gyesei ^{1,*}, Emmanuel Sylvanus Aidoo ², Justice Kobina Asmah ¹¹ Department of Science, St. Vincent College of Education, Yendi, Ghana² Department of Agricultural Science, Diabene Senior High Technical School, Takoradi, Ghana

*Correspondence: Millicent Gyesei (millicentgyesei@gmail.com)

Abstract: This experimental study was carried out to evaluate the effect of three selected pollinator-friendly practices on the African eggplant (*Solanum aethiopicum*) at Mankessim in the Central region of Ghana. The study focused on determining how the practices affect the production and yield of garden eggs. The three pollinator-friendly practices were the use of mulch, cassava hedgerow/marigold plants and controlled pesticide application in garden egg farms. Experimental-control group design was used. Mulching positively influenced the number of flowers, fruits and height of garden eggplants. Cassava hedgerow/marigold plants influenced the number of flowers, but had no significant effect on the number of fruits and plants' height. There was no effect on the number of flowers, fruits, and height of garden eggplants when pesticide application was controlled or uncontrolled. No significant influence was observed in fruit weight in all treatment and control plots. The growth and yield trends observed in this research indicated that practicing the three pollinator-friendly practices may encourage flower visitors leading to effective pollination and increased yields. It is recommended that mulching be practised in garden egg farming to increase the growth and productivity of garden eggplants.

Keywords: Pollinator-Friendly, Garden Eggs, Plants, *Solanum aethiopicum***How to cite this paper:**

Gyesei, M., Aidoo, E. S., & Asmah, J. K. (2023). Effects of Three Selected Pollinator-Friendly Practices on Garden Eggplants (*Solanum aethiopicum*) at Mankessim in the Central Region of Ghana. *Open Journal of Agricultural Research*, 3(1), 28–41. Retrieved from <https://www.scipublications.com/journal/index.php/ojar/article/view/792>

Received: April 8, 2022

Revised: November 22, 2022

Accepted: July 5, 2023

Published: October 6, 2023



Copyright: © 2023 by the authors. Submitted for possible open-access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).

1. Introduction

The garden Eggplant (*Solanum aethiopicum* L. Gilo group) is in the family Solanaceae. It is a native of India and it is said to have been introduced throughout the Mediterranean area by Arabs in the Middle Ages [1]. *S. aethiopicum* is one of the species of *Solanum* extensively cultivated through most of the African continent and more intensively in West and East Africa. The plant is grown both in wet and dry seasons and it is a commodity of great value in the local trade because of its comparatively high yield [2]. It is well-acclimatized to most areas of crop production in the country and frequently grown under rain-fed conditions throughout the rainy season. Minor season production under irrigation similarly takes place [3]. Garden Eggplant is grown for either fruits or leaves depending on the locality [4] and the cultivar_type. The fruits are consumed raw or cooked. They vary from white, cream or yellow in colour with an oval shape and taste from sweet to bitter. When fully matured, the fruits turn red or reddish-orange attributable to increasing carotene content [5]. In Ghana, the leaves, shoots and immature fruits of garden Eggplants are cooked as vegetables in stews but occasionally immature fruits may also be consumed raw [6, 7]. The foremost cultivar groups of *Solanum aethiopicum* are Gilo, Kumba, Shum and Aculeatum. The first three are the most important in Africa with Gilo being the most common group in Ghana whereas the Kumba group

grown for their fruits and the Shum group cultivated for their leaves are more common in other countries [8].

Garden egg has remarkable nutritional characteristics [8]. It serves as an essential food crop that supplements the majority of nutrients required by humans. It is recommended that the intake of a diet rich in fruits and vegetables is linked with a reduced incidence of chronic pathologies such as diabetes, obesity, and cardiovascular diseases [9]. According to [10], the iron-rich content of garden eggs is very helpful to patients suffering from anaemia and also an effective remedy in treating liver complaints. Garden egg enriches the human diet by adding flavour to meals and is a low-cost source of vitamins and minerals. Its value as roughage also enhances digestion and aids in preventing constipation [2].

1.1. Farming Practices at Mankessim

Most farmers at the Mankessim site carry out farming practices that are naturally friendly to pollinators. Some of these practices are traditional and have been passed on from generation to generation. The presence of many forest groves in the landscape, uncultivated river/stream bank vegetation and the use of the hoe and cutlass for control of weeds on farms are some examples. The growing of several crops on the same land in a mixed system and the planting of mixed varieties of the crops together provide multiple sources of forage for pollinators [11].

Farmers in the area are exposed to innovative ways of farming through the agricultural extension system and are adopting improved practices that promote pollinator presence on farms. Amongst the modern practices promoted by the extension services are good nursery practices, the use of mulch to retain soil moisture, avoidance of bush burning for land clearing, the use of hedgerows and the appropriate use of agrochemicals to conserve pollinators [11]. Thus, good agricultural practices contribute immensely to pollinator presence on farms. However, pollinators are under increasing threat from anthropogenic factors. These threats faced by pollinators tend to threaten the many benefits people and ecosystems derive from pollination services. These threats to pollinators are mainly attributed to practices that farmer engage in, on their farms. This study arose as a result of the need to investigate three of the pollinator-friendly practices that promote pollinator presence and conservation in and around garden egg farms.

The three pollinator-friendly practices were investigated because data from the Global Pollination Project (GPP) showed that most farmers are producing low yields and need to enhance production by encouraging pollinator presence on their farms, especially during flowering periods. Observations made showed that farmers collected and burnt all debris which could serve as mulch on their farms. Similarly, garden egg farmers plant hedgerows and this could be encouraged to conserve pollinators, by serving as nesting, resting and hiding sites and protect them from pesticide drift. Finally, farmers misapply various agrochemicals in their garden egg farms. The careful and controlled application of the chemicals will not only help in conserving pollinators but it is expected to increase the yields of garden eggs. This research aimed to evaluate the effect of three pollinator-friendly practices (use of mulch, cassava hedgerow and marigold plants and controlled pesticide application) on garden egg (*Solanum aethiopicum*) production within the Mankessim site of the Global Pollination Project-Ghana. It sought to determine how the selected pollinator-friendly practices affect the production and yield of garden eggs.

1.2. Growth and Development of Garden Eggplant

Epigeal germination occurs in garden Eggplant, after which the cotyledons widen to form a rosette from the first true leaves. More leaves also form which increases in size and within 40-100 days, the flowering of garden Eggplant begins. There is also the branching and subsequent production of smaller leaves during the flower formation. Unlike *Solanum melongena*, all flowers are functionally bisexual and can set fruit. They are mainly

pollinated by bees in the genera *Exomalopsis* and *Apis*. Growth and flowering of garden Eggplant may possibly continue indefinitely, however, suppressed once enough fruits have been set [7].

1.3. Flowers of Garden Eggplant

Flowers of garden Eggplant are bisexual. They are regular with long pedicel, white or pale purple in colour [7, 12]. The anthers are yellow, conniving, and open by terminal pores. The ovary is superior and 2–6-celled while the style is as long as or slightly longer than the stamens. The stigma is also minute and obtuse [13]. The flowers are either single or organised in clusters of two or additional flowers with the stigma bulging either higher (long-styled flower), on the equal level (medium-styled flower) or beneath (short-styled flower) anther tips. The long and medium-styled flowers are described by a well-developed nodule, good pollen absorption capacity, along with permissible tissue rich in polysaccharides, protein and extra nutrients. Cross-pollination is allowed because of the position of the stigma with respect to another tip in long-styled flowers. The short-styled flowers are also characterised by a slight, reduced gynoecium that is usually unproductive; a comparatively small stigma with undeveloped papillae in addition to a spatial separation of anther pores and a minute sugar content which inhibits pollen germination thus ends up in pollen drop [14, 15]. The stamens are inserted close to the base of the corolla tube and alternate with corolla lobes. They have filaments which are short and thick and inflorescence is lateral, racemose cyme (5-12) flowers having a peduncle generally short or absent. (Figure 1) [7, 12].

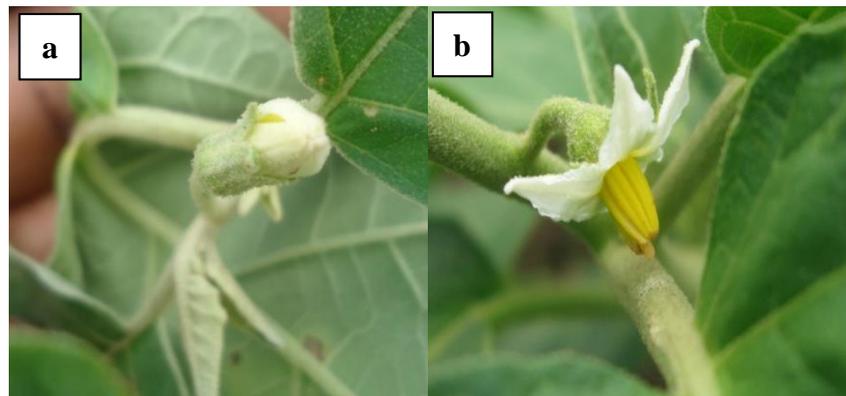


Figure 1. Flowers of garden Eggplant (a) Unopened flowers and (b) Opened flowers

Fruits of Garden Eggplant

Fruits of gilo group range from subglobose to ellipsoid with 2.5–12 cm in length and diameter of 3–6 [16]. The fruits are borne either singly or in clusters [13]. Differences have been observed in fruit shape, immature fruit colour, fruit size, diameter of corolla and taste. Fruit varies from smooth to more or less strongly ribbed. Garden eggs are of bitter to sweet taste depending on their saponin content and are consumed cooked or raw. The colour of the fruit may differ from pure white, creamy white or yellow and some of the fruits may be striped with two or more colours. At full maturity, they turn red to orange due to their carotene content (Figure 2) [17, 10].



Figure 2. Fruits of garden Eggplant (a) Mature fruits and (b) Ripened fruits

1.4. General Pollinator-friendly Practices

1.4.1. Influence of Mulching Material

One technique for increasing the profitability of crops is soil mulching [18]. Mulching is one of the most beneficial practices that can be applied in the field. It has been defined by various authors as the method of spreading organic matter around plants as this provides frost protection for roots [19, 20]. Mulches can either be organic such as grass clippings, straw, and bark chips or inorganic such as stones, brick chips, and plastics. Both organic and inorganic mulches are of enormous benefits [21].

1.4.2. Influence of hedgerows

Hedgerows are strips of land or rows of trees that enclose farm fields [22, 23]. They are planted with crops that have many flowers to attract insect pollinators to the field. Hedgerows are important in serving as food and nesting resources for a variety of animals, as well as pollinators such as birds, bats and insects [24]. Additionally, they also offer benefits by acting as living fences and boundary lines, functioning as protection for sensitive insects from pesticide drift. Hedgerows are a source of aesthetic resources and ensure air and water quality protection [25].

1.5. Influence of Controlled Pesticides Application

Pesticides in agriculture are mainly used in controlling insect pests, diseases and weeds. They are known to increase agricultural production as they act on pests that reduce agricultural yield. The performance of a pesticide in the environment is influenced by the organisms existing in the soil and their prevailing climatic conditions, physico-chemical properties, the nature of the medium into which it is applied, its stability, and the organisms present in the soil [26]. According to [27] pesticide usage causes a lot of harm to nature and ecology biodiversity. They ruin pollinators such as wild bee populations and their products like honey totally due to their toxicity [28]. Pesticides are documented to be possibly the most destructive agrochemicals to pollinators [29, 30]. The overuse of pesticides (insecticides/herbicides/fungicides) can practically lead to pollinators' death. [30]. They are toxic but reasonable use will help control pest species that are detrimental to crops and also allow for the conservation of pollinators in their associated natural systems.

2. Materials and Methods

2.1. Study Site

The experiment was conducted at one of the Study, Training, Evaluation and Promotion (STEP) sites of the Global Pollination Project (GPP) at Enyan Apaah-

Mankessim between June 2013 and January 2014 in the Central Region of Ghana (Figure 3). Three farmers' fields at Enyan Apaah, a perfect site of GPP were selected for the study. The site is located in the Eastern part of Mfantseman district. The study site has transitional vegetation between the coastal scrubland and dry semi-deciduous forest. There are two distinct rainy seasons; the major rainy season and the minor rainy season. Rainfall ranges between 90 cm-110 cm in the coastal savannah areas and between 110 cm and 160 cm in the interior close to the forest zone with peaks in the month of May, June and October. The area is low-lying with an elevation between 1.2 m and 52 m above sea level and is serviced by the Okye River with a number of tributaries. There is a large water body at the western part of the site as a result of a dam created by the Irrigation Development Authority (IDA) of Ghana. The soil is brownish in colour and has both clayey and sandy characteristics making it ideal for cultivation. It has a medium-fine texture; and although well-drained, it has the ability to hold water for long periods [31, 11].

2.1.1. Treatment Sites

2.1.1.1. Location one: mulch and no mulch garden egg farm

This area is located at latitude 05°18.593' N and at an elevation of 000° 59.833' W 22 m. It is located about 3 km away from Enyan Apaah township and the site measures 79.3 m x 51 m. The experimental plots (Mulch) and control plots (No-mulch) were separated from one another by a 2 m fallow area. Garden Eggplants assigned as experimental plots were mulched with dry maize stubble while no-mulch garden Eggplants served as the control plots.

2.1.1.2. Location two: cassava hedgerow/marigold and no hedgerow/marigold farm

This farm is located at latitude 05°18.246' N and at an elevation of 000° 58.976' W 22 m. It is located about 2 km from Enyan Apaah township and measures 83 m x 40 m. The experimental plots (Cassava hedgerow/marigold plant) and control plots (No cassava hedgerow/marigold plant) were separated by a 2 m fallow area. Garden Eggplants produced under Cassava hedgerow/marigold conditions represented the experimental plots while plants under no cassava hedgerow/marigold represented the control plots.

2.1.1.3. Location three: controlled and uncontrolled pesticide application farm

This area is located at latitude 05°18.883' N and at an elevation of 000° 58.628' W 38 m. It is located about 1 km from Enyan Apaah township and has an area of 60 m x 50 m. The experimental plots and control plots were separated by a 2 m fallow area. Plants on the experimental plots (controlled pesticide application) were sprayed at every two weeks only three times. On the other hand, garden Eggplants serving as the control plots (Uncontrolled pesticide application) were sprayed for twelve weeks every two weeks.

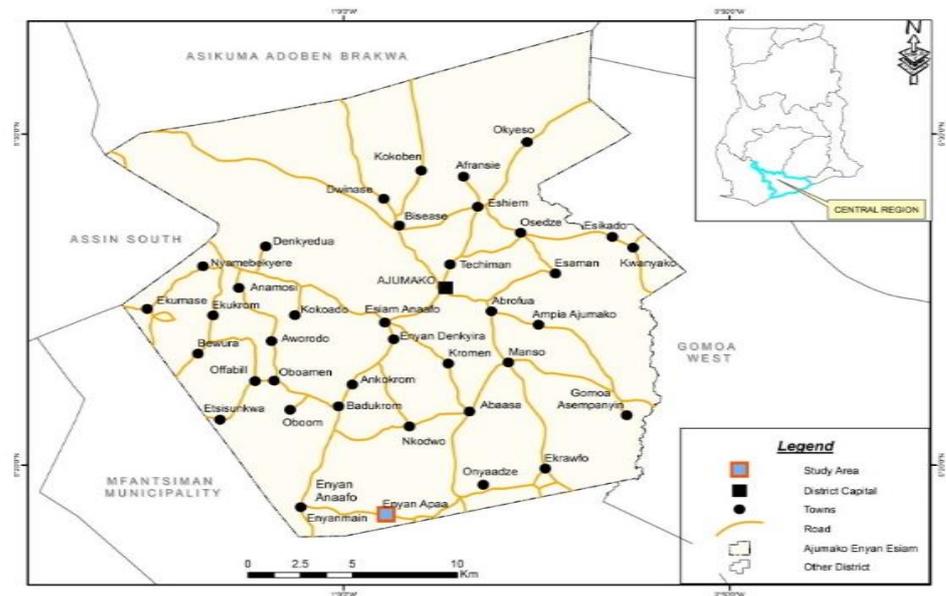


Figure 3. Map of the Central region of Ghana showing the study area.

2.2. Spraying times and pesticides used

Spraying of pesticides on controlled and uncontrolled plots was done on Wednesdays at 9 a.m. with a spraying gun. The pesticide used for spraying was evergreen pesticides which contained pyrethrums.

2.3. Experimental Treatments and Field Layout

There were three different treatment plots with their corresponding control plots. The treatments were mulch, cassava hedgerow/marigold plants and controlled application of pesticides each with five replications. Each replicate had four (4) plants making a total of twenty (20) plants per treatment. The treatments used were termed three pollinator-friendly practices and these were investigated in this study. Garden egg seeds were obtained from fresh fruits of garden Eggplants grown by farmers at Enyan Apaah. The variety grown was 'Aworoworo'. The experimental farms were cleared, ploughed, harrowed and pegged for cultivation. Seeds of 'aworoworo' were nursed for four weeks before transplanting. The seedlings were transplanted at 1 m × 1 m spacing for all treatment plots and their corresponding control plots.

3. Results on the Effect of the Three Pollinator-friendly Practices on the Growth of Garden Eggs

Differences were observed in the growth of garden eggplant (*Solanum aethiopicum*) under the three pollinator-friendly practices in relation to their flowering, fruiting, plant height and fruit weight.

3.1. Effect of mulch, cassava hedgerow/marigold plants (CHM) and pesticide application on height of garden Eggplants

A higher mean height of (136.7cm) was recorded for plants treated with mulch ($T = \text{Value} = 2.40, P = 0.040$) compared to 113.6 cm for plants with no mulch. On the other hand, garden Eggplants produced under no cassava hedgerow/marigold (NCHM) gave a higher (129.9 cm) mean height but was not significantly different ($T = -0.91, P\text{-Value} = 0.387$) from those on the experimental plots, (CHM) which had a mean height of 118.9 cm. There was also no significant difference ($T = 0.15, P = 0.888$) observed in plant height between

uncontrolled and controlled pesticide application. The mean height of garden eggplants that received uncontrolled pesticide application was (95.0 cm) while plants treated with controlled pesticide application were 96.1 cm at ($P < 0.05$) (Table 1).

Table 1. Mean height of 10 plants for the three treatments

Treatments	Plant height (cm)
	Mean \pm S.e
Mulch	136.7 \pm 6.94
No mulch	113.6 \pm 3.83
Cassava hedgerow/marigold	118.9 \pm 8.10
No cassava hedgerow/marigold	129.9 \pm 7.50
Controlled Pesticides	96.1 \pm 5.14
Uncontrolled Pesticides	95.0 \pm 4.38

3.2. Effect of mulching on the number of flowers and fruits

The mean number of flowers per plant per week was higher (5.28) in mulched plants than in plants without mulch (4.36) (Figure 4). Plants that were mulched flowered significantly ($T = 2.93$, $P = 0.004$) than garden eggplant without mulch. Additionally, the mean number of fruits per plant per week was significantly higher ($T = 3.98$, $P = 0.000$) in mulched plants than in plants without mulch. Mulched plants recorded a higher number of fruits (2.24) than plants without mulched (1.74) (Figure 5).

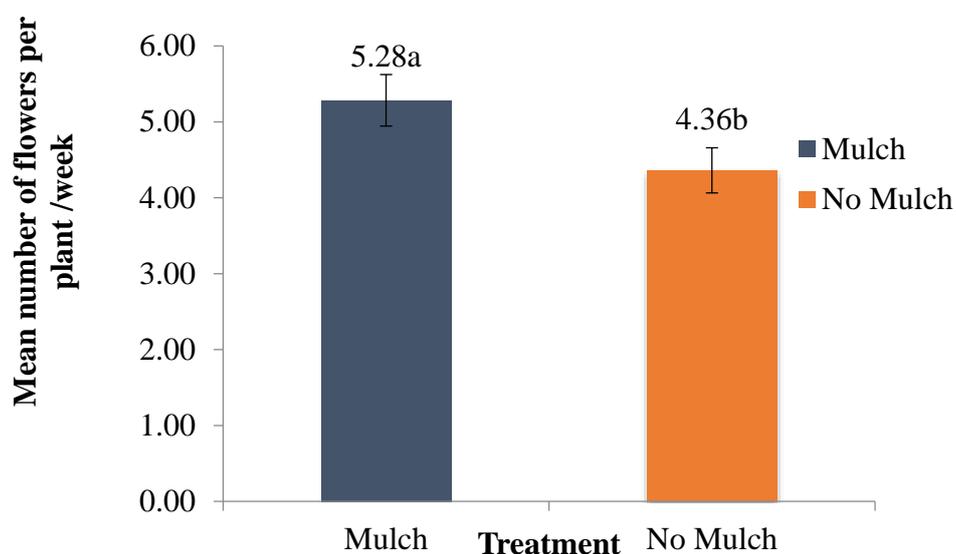


Figure 4. Number of flowers produced by plant under mulch and no mulch conditions

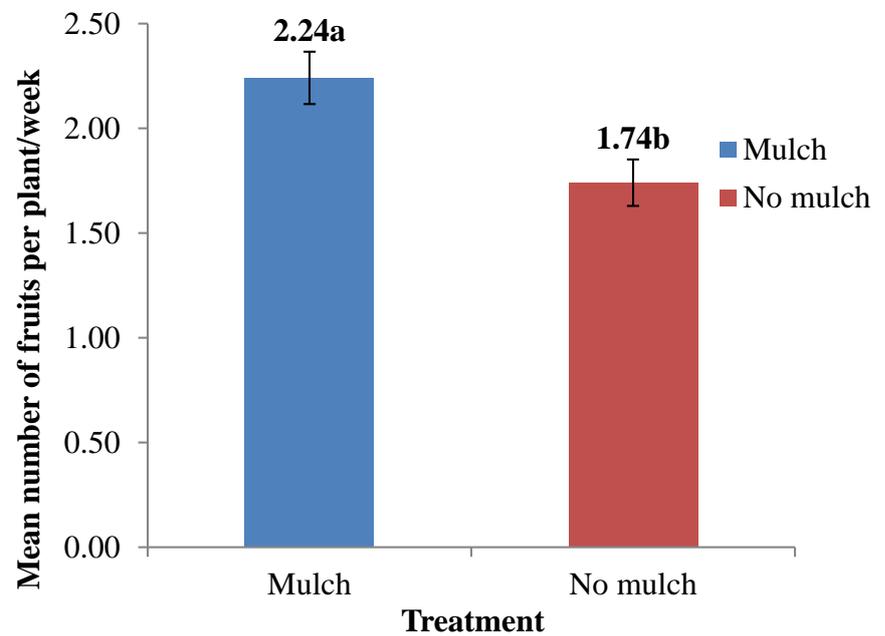


Figure 5. Number of fruits produced by garden eggs under mulch and no mulch conditions.

Effect of cassava hedgerow/marigold on the number of flowers and fruits

The observed difference between the mean number of flowers of garden Eggplants under hedgerow and without hedgerow was not significant ($T = 0.50$, $P = 0.620$). The mean number of flowers per plant under the cassava hedgerow/marigold (CHM) treatment was however slightly higher (5.94) than plants without the cassava hedgerow and marigold (NCHM) (5.82) (Figure 6).

On the other hand, the mean number of fruits per plant was not significantly higher in hedgerow/marigold plots ($T = 3.58$, $P = 0.000$) than those without cassava hedgerow and marigold at a 5% level of significance. Garden Eggplants under hedgerow/marigold treatment gave a higher mean (2.17) than plots grown without cassava hedgerow/marigold (1.63) (Figure 7).

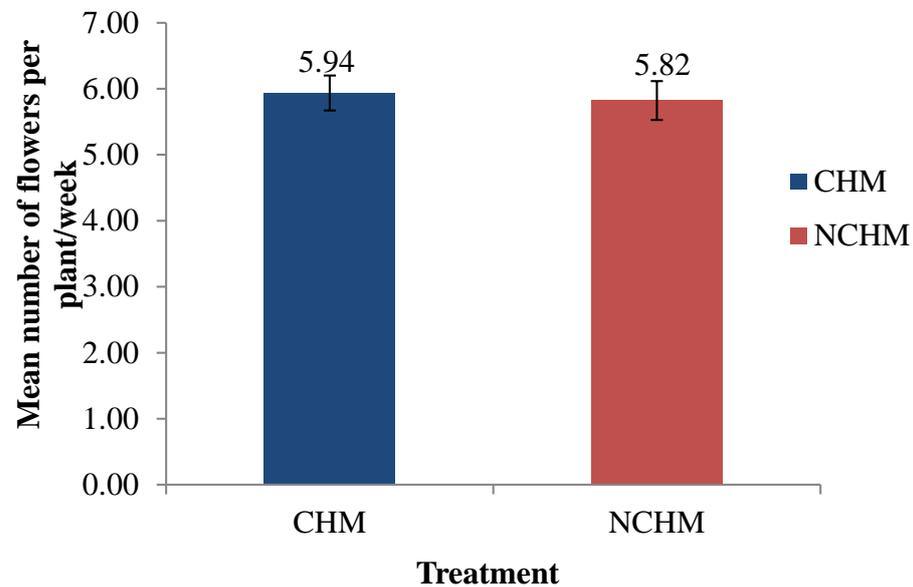


Figure 6. Number of flowers produced by garden eggs under cassava hedgerow/ marigold plants and no cassava hedgerow/marigold plants conditions

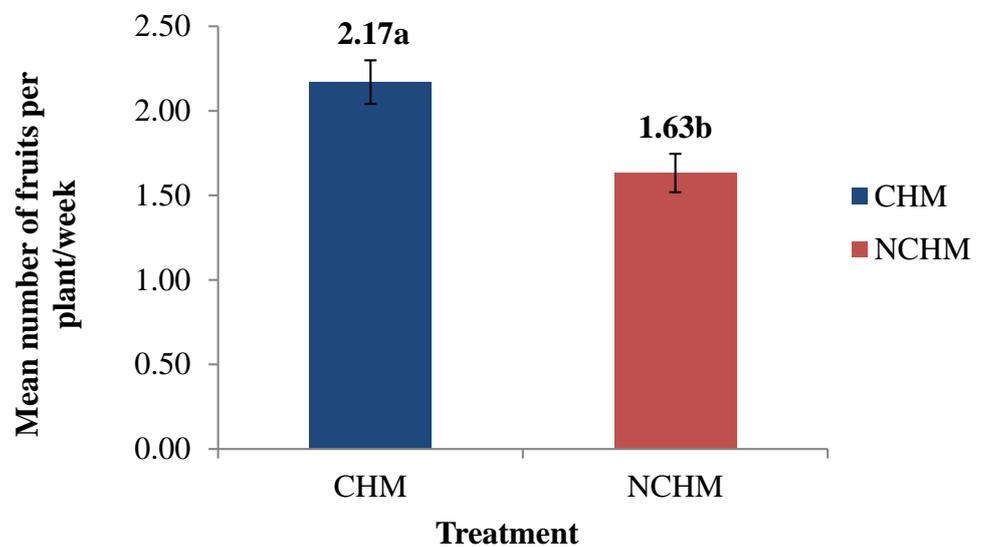


Figure 7. Number of fruits produced by garden eggs under cassava hedgerow/marigold plants and no cassava hedgerow/marigold conditions.

3.3. Effect of pesticide on the number of flowers and fruits in garden Eggplants

The mean number of flowers recorded from garden Eggplants under controlled and uncontrolled application of pesticides did not differ significantly ($T=0.43$, $P=0.670$) at 5% level of significance. Nevertheless, plots that received controlled pesticide application yielded a higher number of flowers (8.17) compared to those from plants in fields that received uncontrolled pesticide application (8.06) per plant per week. (Figure 8). Again, the mean number of fruits that were recorded from garden Eggplants from fields of

controlled and uncontrolled pesticide farms showed no difference ($T = 1.44$, $P = 0.151$) at a 5% level of significance. However, the mean number of fruits under controlled pesticide application (2.28) was slightly higher than those treated with uncontrolled pesticides (2.07) per plant per week (Figure 9).

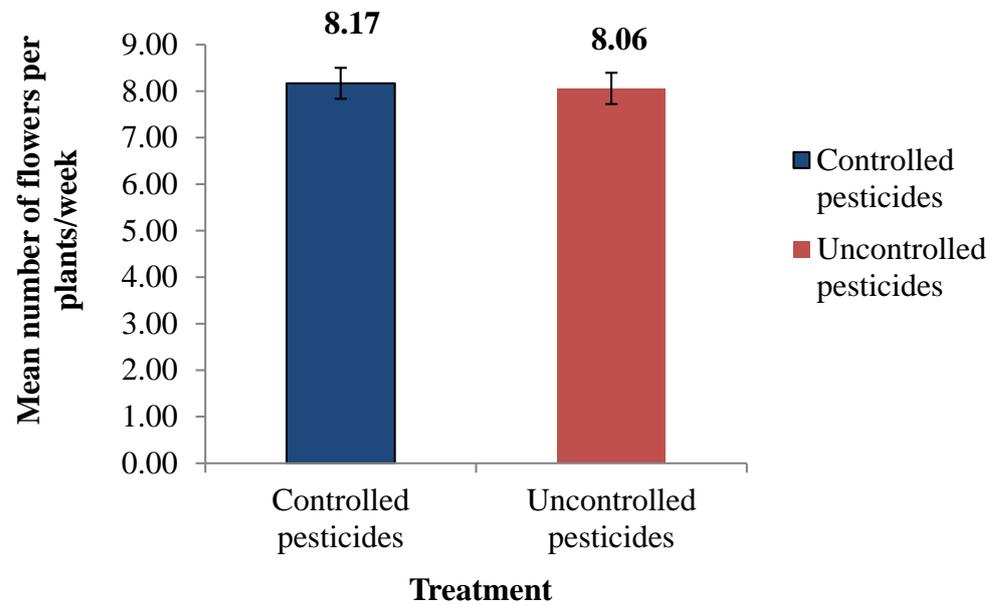


Figure 8. Number of flowers produced by garden eggs under controlled and uncontrolled pesticide application.

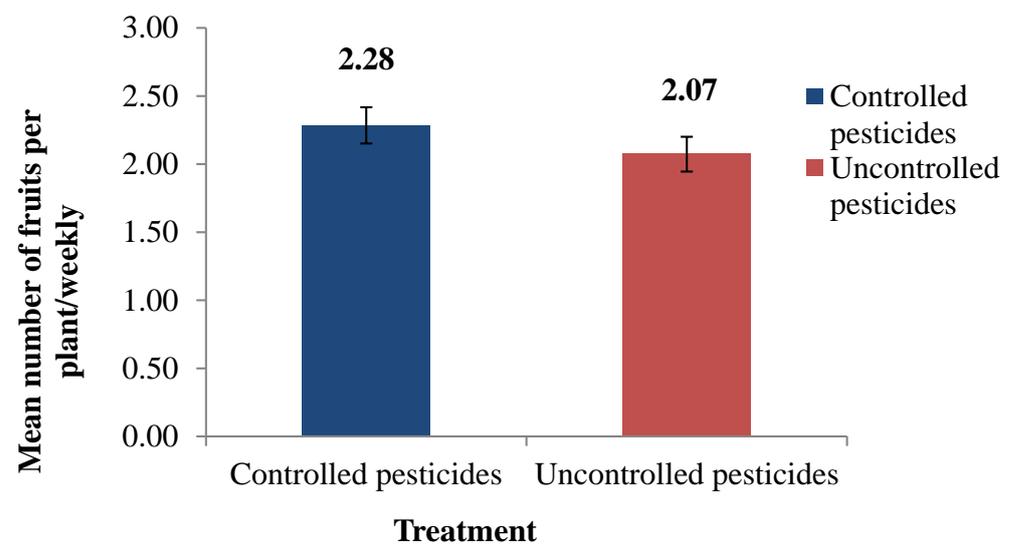


Figure 9. Number of fruits produced by garden eggs under the treatment of controlled and uncontrolled pesticide application.

3.3.1. Effect of mulch, cassava hedgerow/marigold plants and pesticide application on fruit weight

A higher fruit yield (1.40 kg) was recorded from mulched garden egg plots but this was not significantly different ($T = 7.00$, $P = 0.090$) from no mulch plots (1.05kg). Similarly, plants on plots with cassava hedgerow/marigold gave a higher yield (1.55kg) but were not significant ($T = 5.00$, $P = 0.126$) from control plots (1.30 kg). Garden Eggplants under controlled pesticide application produced a higher yield (1.60 kg) compared with those under uncontrolled pesticide application (1.40 kg). There was however no significant difference ($T = 2.00$, $P = 0.295$) between the two (Table 2).

Table 2. The mean weight of 20 fruits for the three treatments

Treatments	Fruit weight (kg)
	Mean \pm S.e
Mulch	1.40 \pm 0.600
No mulch	1.05 \pm 0.550
Cassava hedgerow/marigold	1.55 \pm 0.650
No cassava hedgerow/marigold	1.30 \pm 0.700
Controlled Pesticides	1.60 \pm 0.500
Uncontrolled Pesticides	1.40 \pm 0.600

4. Discussion

4.1. Effect of mulch on the growth of garden egg

The results from the study revealed differences in the growth and yield of garden Eggplants under the three pollinator-friendly practices. The height of garden Eggplants, flowering and fruiting of the plants varied considerably under the three treatments evaluated in this study. The application of maize stubbles as mulching material significantly enhanced the growth and yield parameters of garden eggs in terms of the number of flowers per plant, number of fruits per plant and height of plants. However, the control (no mulch) recorded the minimum growth and yield. The increase in growth parameters could be ascribed to sufficient soil moisture near the root zone, ensuring good conditions necessary for plant growth. Mulching minimised the loss of water due to evaporation. Additionally, nutrients were added to the soil during the decomposition of the mulching material, thus ensuring healthy plant growth. The prolonged retention of soil moisture and the uptake of water from the soil may have led to a greater uptake of soil nutrients for the improvement of plants as compared to the control which was not mulched. Inferring from the results of this study, the improved growth obtained from using maize material is a remarkable contribution to agriculture in Ghana and other developing countries as low-income farmers can depend on such materials for improved soil fertility and the resultant increase in the production of garden eggs and other vegetables.

4.2. Effect of cassava hedgerow and marigold plants

The data showed that cassava hedgerow/marigold plants did not have any significant effect on the number of fruits produced by the garden Eggplants. However,

significantly, more flowers were produced under cassava hedgerow/marigold plants compared to the control plots. This may be attributed to the fact that some of the flowers of garden Eggplants in the controls failed to form fruits. More flowers produced by garden Eggplants under cassava hedgerow/marigold conditions could result from the effective pollination received by these plants from pollinators. Flowers of cassava hedgerows attracted more pollinators to the farm. These pollinators then moved on to the flowers of garden Eggplants pollinating them. More flowers were then produced contributing to the formation of fruits.

4.3. Effect of pesticides in a garden egg farm

In this study, plots that received controlled application of pesticides recorded a higher number of flowers and fruits than plots of uncontrolled pesticide application. However, the observed difference was not statistically significant. The number of flowers produced was not related to pesticide application. Therefore, the pesticides used did not affect the growth of garden Eggplants on either controlled or uncontrolled pesticide farms.

5. Conclusions

The purpose of the study was to evaluate the effect of three pollinator-friendly practices (use of mulch, cassava hedgerow/marigold plants and controlled pesticide application) on garden egg (*Solanum aethiopicum*) production within the Mankessim site of the Global Pollination Project-Ghana. Garden egg (*Solanum aethiopicum*) growth and production evaluated under the three pollinator-friendly practices showed wide differences especially when maize stubbles were used as mulching material. Garden egg yield was significantly higher in mulched plots than in the control plots. The results revealed that mulching positively influenced the number of flowers, fruits and height of garden Eggplants. Using cassava hedgerows and marigolds did not have a significant influence on the number of flowers and height of garden Eggplants. However, significantly more fruits were produced under cassava hedgerow and marigold conditions. Controlled and uncontrolled pesticide application did not have any significant influence on the number of flowers, fruits and height of garden Eggplants. The treatments did not affect the weight of garden eggs. The growth and yield trends observed in this research indicated that practicing the three pollinator-friendly practices may encourage flower visitors leading to effective pollination and increased yields.

6. Recommendations

Given that the data have shown wide differences in the flowering and fruiting of garden Eggplants when the three pollinator-friendly practices were evaluated, it is strongly recommended that mulching as a pollinator-friendly practice be adopted in our traditional farming as it encourages pollinators and increases yields. Secondly, the planting of cassava as hedgerows by farmers as an alternative food source in their garden egg farms should be continued as a pollinator-friendly practice in garden egg production. The study further proposes that similar studies can be conducted on how the decomposition of mulching material improves soil fertility for the growth and production of high-quality garden eggs.

Author's Contributions: Conceptualization MG; methodology MG, ESA and JKA; validation MG, ESA and JKA; formal analysis MG, ESA and JKA; investigation MG, ESA and JKA; resources MG, ESA and JKA; data curation MG, ESA and JKA; writing—original draft preparation MG; writing—review and editing MG, ESA and JKA; visualization MG, ESA and JKA; supervision MG; project

administration MG, ESA and JKA. All authors have read and agreed to the published version of the manuscript.

Funding: “This research received no external funding”

Data Availability Statement: Data is available on request from the corresponding author.

Acknowledgements: We acknowledge the respondents for their time and patience.

Conflicts of Interest: “The authors declare no conflict of interest.” “No funders had any role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results”.

References

- [1] Christo, I. E., Okorie, H. A., & Njoku, C. (2011). Performance of eggplant (*Solanum gilo* L.) as affected by manure types and rates. *Global Research Journal of Science*, 1, 43–47. Retrieved October 14, 2000, from <http://www.academicpublications.org/grjs>.
- [2] Ekwu, L., Utobo, E. B., & Nwokwu, G. N. (2012). Effect of NPK fertilizer and weeding regime on the growth and yield of Eggplant (*Solanum melongena* L.) in Abakaliki. *International Journal of Agriculture and Rural Development*, 15(2), 1033–1040.
- [3] Denkyirah, E. (2013). *Variation in floral morphology, fruit set and seed quality of garden egg (Solanum aethiopicum var gilo) germplasm in Ghana*. Unpublished Masters Thesis, University of Ghana. Retrieved from <http://ugspace.ug.edu.gh>
- [4] Khalid, A. A., Tuffour, H. O., Bonsu, M., Adjei-Gyapong, T., & Abubakar, A. (2014). Effects of poultry manure and NPK fertilizer on growth and yield of garden eggs (*Solanum melongena*) in sandy soil in Ghana. *International Journal of Scientific Research in Knowledge*, 2(6), 257–264. Retrieved from <http://www.ijsrpub.com/ijsrk>
- [5] Agnieszka, S., Cebula, S., & Kunicki, E. (2007). Origin, breeding, objectives and genetic resources. *Cultivated eggplants*, 19 (1), 97-114.
- [6] Grubben, G. J. H., & Denton, O. A. (2004). *Plant Resources of Tropical Africa II: Vegetables*. Leiden, Wageningen: Backhuys Publishers.
- [7] Lester, R. N., & Seck, A. (2004). *Solanum aethiopicum* L. Record from Protabase. In Grubben, G. J. H., & Denton, O. A. (Eds.), *Plant Resources of Tropical Africa/ Resources Vegetables de l’AfriqueTropicale*. Wageningen, Netherlands. Retrieved March 17, 2012, from <http://database.prota.org/search.htm>.
- [8] Horal, J. D., Timpo, S., & Gruere, G. (2007). Marketing underutilized crops: The case of the African garden egg (*Solanum aethiopicum*) in Ghana. Global Facilitation Unit for Underutilized Species (GFU) ViadeiTreDenri, Rome, Italy.
- [9] Edijala, J. K., Asagba, S. O., Eriyamremu, G. E., & Atomatofa, U. (2005). Comparative effect of garden egg fruit, oat and apple on serum lipid profile in rats fed a high cholesterol diet. *Pakistan Journal of Nutrition*, 4(4), 245–249.
- [10] Chinedu, S. N., Olasumbo, A.C., Eboji, O. K., Emiloju, O. C., Arinola, O. K., & Dania, D. I. (2011). Proximate and Phytochemical analyses of *Solanum aethiopicum* L. and *Solanum macrocarpon* L. Fruits. *Research Journal of Chemical Sciences*, 1(3), 63-71
- [11] GPP. (2014). Pollinator-friendly practices. Retrieved from www.globalpollinationprojectghana.org
- [12] PROTA. (2004). PROTA Foundation / Backhuys Publishers / CTA Wageningen, Netherlands, pp 472-473.
- [13] Som, M. G., & Maity, T. K. (1986). Brinjal In Bose & Som (Ed.), *Vegetable Crops in India*. Calcutta, India, May Prokash. pp. 293-341
- [14] Chen, N. C. (2001). Eggplant seed production. AVRDC, *International Cooperators’ Guide*. Shanhua, Taiwan Asian Vegetables: Research and Development Center.
- [15] Sekara, A., & Bieniasz, M. (2008). Pollination, fertilization and fruit formation in eggplant (*Solanum melongena* L.). *Acta Agronomica Botanica*, 61(1), 107-113.
- [16] Tindall, H. D. (1976). *Fruit and vegetables in West Africa*. FAO Plant Production and Protection Series. Rome, FAO.
- [17] FAO. (2009). Good agricultural practices for African indigenous vegetables. In R. Nono-Womdim, C. Ojiewo, M. Abang, & M. O. Oluoch (Eds.), *Proceedings of a Technical Consultation Workshop* (pp. 7–8). Arusha, Tanzania: International Society for Horticultural Science.
- [18] Awoodoyin, R. O., Ogebeide, F. L., & Oluwole, O. (2007). Effects of three mulch types on the growth and yield of tomato (*Lycopersicon esculentum* Mill.) and weed suppression in Ibadan; Rainforest-savanna transition zone of Nigeria. *Tropical Agricultural Research and Extension*, 10, 53-60.
- [19] Campiglia, E., Caporali, F., Radicetti, E., & Mancinelli, R. (2010). Hairy vetch (*Vicia villosa* Roth.) covers crop residue management for improving weed control and yield in no-tillage tomato (*Lycopersicon esculentum* Mill.) production. *European Journal of Agronomy*, 33, 94–102.
- [20] Mulvaney, M. J., Price, A. J., & Wood, C. W. (2011). Cover crop residue and organic mulches provide weed control during limited-input no-till collard production. *Journal of Sustainable Agriculture*, 35, 312–328.

-
- [21] USDA. (1998). *Mulching enriches and protects soil, helping provide a better growing environment*. Washington: National Association of Conservation Districts.
- [22] CAFF. (2004). Hedgerows for California Agriculture: A Resource Guide. Retrieved 5, December 2011, from caff.org/programs/bio-ag/hedgerows/, pp.70.
- [23] Long, R. F., & Anderson, J. (2010). Establishing hedgerows on farms in California. *Agriculture and Natural Resources Publication 8390*. Available from <http://ucanr.org/freepubs/docs/8390.pdf>.
- [24] Marshall, E. J. P., Brown, V. K., Boatman, N. D., Lutman, P. J. W., Squire, G. R., & Ward, L. K. (2003). *The role of weeds in supporting biological diversity within crop fields*. *Weed Resin*, 43, 77–89.
- [25] Hannon, L. E., & Sisk T. D. (2009). Hedgerows in an agri-natural landscape: Potential habitat value for native bees. *Biology Conservation*, 142, 2140–2154.
- [26] Graham-Bryce I. J. (1981). The behaviour of pesticides in soil. In D. J. Greenland & M. H. B Hayes (Ed.), *The Chemistry of Soil Processes*. John Wiley and Sons Limited.
- [27] Tegtemeier, E. M., & Duffy, D. (2004). External Cost of Agriculture Production in the United States of America. *Indian Journal of Agricultural Sustainability*, 2(1), 1-20.
- [28] Chauzat, M. P., Marte, I. A. C., Cougoule, N., Porta, P., Lachaize, J., Zeggane, S., & Faucon, J. P. (2011). An assessment of honeybee colony matrices, *Apis mellifera* (Hymenoptera: Apidae) to monitor pesticide presence in continental France. *Environmental Toxicity and Chemistry*, 30(1), 103–111.
- [29] Batley, M., Hogendoorn, K., (2009). Diversity and conservation status of native Australian bees. *Apidologie*, 40, 347–354.
- [30] Byrne, A., & Fitzpatrick, Ú. (2009). Bee conservation policy at the global, regional and national levels. *Apidologie*, 40, 194–210.
- [31] Opere-Ankrah, Y. (2007). *The bushmeat trade, livelihood securities and alternative wildlife resources: A case study of Mankessim and its environs in the Mfantseman District (Ghana)*. Norwegian University of Science and Technology (NTNU).